New York State
DEPARTMENT OF ENVIRONMENTAL CONSERVATION

Division of Water

Salmon Creek
Biological Assessment

2005 Survey

New York State
Department of Environmental Conservation

George E. Pataki, Governor   Denise M. Sheehan, Acting Commissioner

SALMON CREEK
BIOLOGICAL ASSESSMENT

Seneca-Oneida-Oswego Basin
Cayuga County, New York

Survey date: July 26-27, 2005
Report date: October 27, 2005

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CONTENTS

Stream: Salmon Creek, Cayuga and Tompkins County, New York

Reach: Bolts Corners to Ludlowville, New York

Drainage basin: Seneca-Oneida-Oswego Rivers Basin

Background:

The Stream Biomonitoring Unit sampled Salmon Creek in Cayuga County, New York, on July 26-27, 2005. The purpose of the sampling was to assess overall water quality and determine if the stream is significantly impacted by Willet Dairy, in East Genoa. In riffle areas at six sites, a traveling kick sample for macroinvertebrates was taken, using methods described in the Quality Assurance document (Bode et al., 2002) and summarized in Appendix I. The contents of each sample were field-inspected to determine major groups of organisms present, and then preserved in alcohol for laboratory inspection of a 100-specimen subsample from each site. Macroinvertebrate community parameters used in the determination of water quality included species richness, biotic index, EPT richness, and percent model affinity (see Appendices II and III). Expected variability of results is stated in Smith and Bode (2004). Table 2 provides a listing of sampling sites and Table 3 provides a listing of all macroinvertebrate species collected in the present survey. This is followed by macroinvertebrate data reports, including raw data from each site.

Thanks to Scott Cook, NYSDEC Region 7, for assistance in the survey.

Results and Conclusions:

1. Water quality in Salmon Creek was assessed as slightly to moderately impacted. Nutrient enrichment was indicated to be the primary stressor causing impact. Longitudinal trends in the creek show water quality declining from Bolts Corners to Forks of the Creek, and improving somewhat from there to the mouth.

2. No measurable impacts in Salmon Creek are assignable to Willet Dairy.

Discussion

Salmon Creek originates as the confluence of Big Salmon Creek and Little Salmon Creek at Forks of the Creek. It flows south for 8.2 stream miles, before entering Cayuga Lake at Ludlowville. Big Salmon Creek, which originates as the outlet of a small pond near Scipio Center, Cayuga County, flows for 14.8 miles before joining Little Salmon Creek to form Salmon Creek. Salmon Creek is classified as C(TS), and receives spring stocking of brown trout. Big Salmon Creek from the source to Tributary 31, near East Venice is classified as C, and as C(T) from Tributary 31 to the confluence with Little Salmon Creek.

Salmon Creek was previously sampled by the Stream Biomonitoring Unit at the Ludlowville site (Station 6) in 1996, 2001, and 2002. In 1996 water quality was assessed as non-impacted, based on field assessment Water quality was assessed as slightly impacted in 2001 and 2002. . The Genoa site on Big Salmon Creek (Station 2) was sampled in 1998 and 2000, and was assessed as moderately impacted by nutrient enrichment both years. Little Salmon Creek was sampled in 1996 and water quality was assessed as non-impacted.

In the present sampling, water quality in Salmon Creek was assessed as slightly impacted to moderately impacted over the 8-mile reach sampled, and Big Salmon Creek was assessed as slightly impacted (Figure 1). Nutrient enrichment was indicated to be the primary stressor causing the impact (Table 1). Longitudinal trends in the creek show water quality declining from Bolts Corners to Forks of the Creek(Station 3), and improving somewhat from there to the mouth. Little Salmon Creek was not sampled at this time, but it is likely that it contributes good quality water, based on its 1996 assessment, and is partially responsible for the improvement. This is not evidenced at the first site below the confluence (Station 3), possibly due to incomplete mixing.

No measurable impacts were seen from Willet Dairy, which is within the drainage of the unnamed tributary entering Salmon Creek between Stations 3 and 4. Although the tributary was dry at the time of sampling, and could not be sampled, this does not preclude the possibility of detecting impacts downstream, since the biota integrates effects over time (see Appendix VIII). The basin is heavily dominated by agriculture, and nutrient enrichment is a concern for the entire watershed. In the reach sampled, the stream shows no impacts indicative of a single source or discharge.

Literature Cited:

Bode, R. W., M. A. Novak, L. E. Abele, D. L. Heitzman, and A. J. Smith. 2002. Quality assurance work plan for biological stream monitoring in New York State. New York State Department of Environmental Conservation, Technical Report, 115 pages.

Smith, A. J. and R. W. Bode. 2004. Analysis of variability in New York State benthic macroinvertebrate samples. New York State Department of Environmental Conservation, Technical Report, 43 pages.

Overview of field data

On the dates of sampling, July 26-27, 2005, Salmon Creek at the sites sampled was 1-10 meters wide, 0.1 meters deep, and had current speeds of 40-100 cm/sec in riffles. Dissolved oxygen was 7.8-11.1 mg/l, specific conductance was 365-652 μmhos, pH was 7.7-8.2 and temperature was 20.9-24.5 °C (70-76 °F). Measurements for each site are found on the Field Data Summary sheets.

Figure 1. Biological Assessment Profile of index values, Salmon Creek, 2005. Values are plotted on a normalized scale of water quality. The line connects the mean of the four values for each site, representing species richness, EPT richness, Hilsenhoff Biotic Index, and Percent Model Affinity. See Appendix IV for more complete explanation.

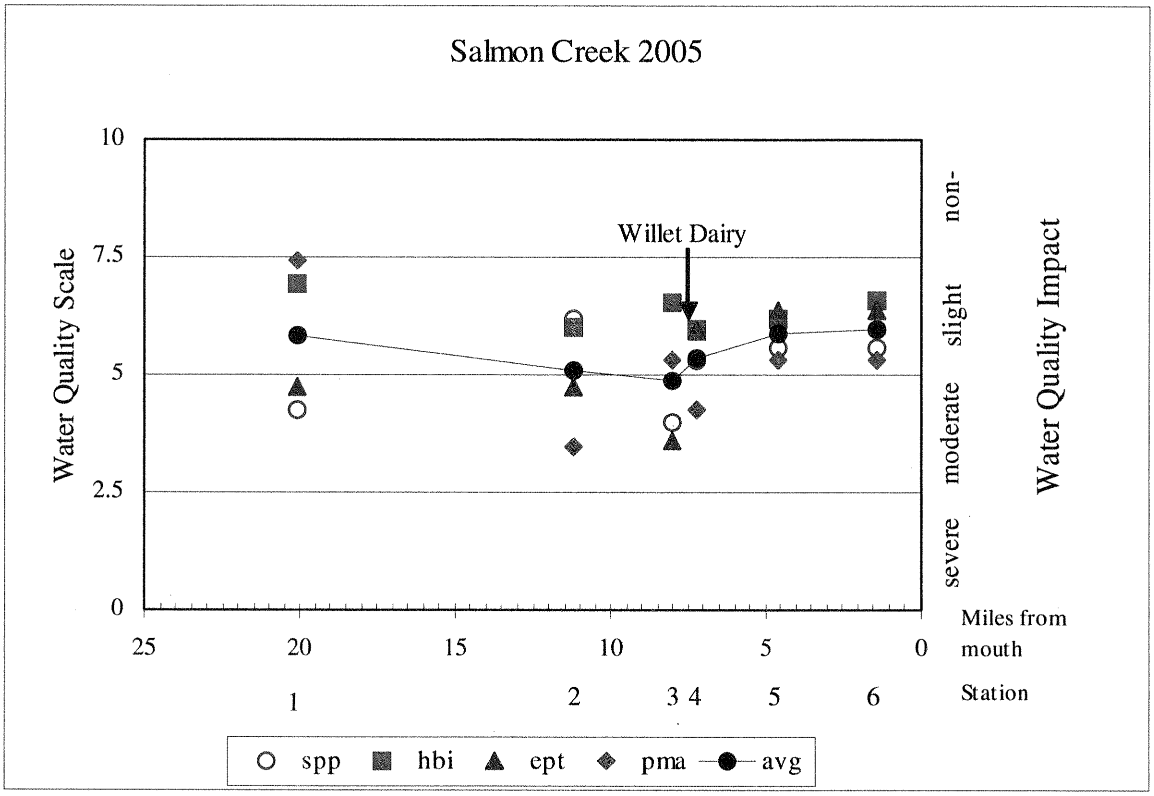


Table 1. Impact Source Determination, Salmon Creek, 2005. Numbers represent similarity to macroinvertebrate community type models for each impact category. The highest similarities at each station are highlighted. Similarities less than 50% are less conclusive. Highest numbers represent probable type of impact. See Appendix X for further explanation.

	STATION					
Community Type	SMON-01	SMON-02	SMON-03	SMON-04	SMON-05	SMON-06
Natural: minimal human impacts	41	35	30	38	37	30
Nutrient additions; mostly nonpoint, agricultural	49	61	52	52	56	53
Toxic: industrial, municipal, or urban run-off	47	52	35	60	59	40
Organic: sewage effluent, animal wastes	27	57	51	42	50	49
Complex: municipal/industrial	35	59	45	52	56	52
Siltation	39	48	41	66	60	36
Impoundment	32	63 *	54 *	57 *	50	54

STATION	COMMUNITY TYPE
SMON-1	Nutrients, toxics
SMON-2	Nutrients, organics
SMON-3	Nutrients, organics
SMON-4	Siltation
SMON-5	Nutrients, toxics, complex, siltation
SMON-6	Nutrients, complex

* Indications of impoundment effects are considered spurious.

Table 2. Station Locations for Salmon Creek, Cayuga County, NY

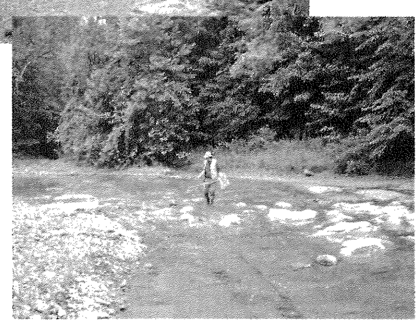
STATION	LOCATION	
01	Bolts Corners, New York Below Sherwood Road bridge Latitude/Longitude 42° 45' 50"; 76° 34' 24" 20.1 stream miles above mouth	[no photo available]
02	Genoa, New York Above Route 90 bridge Latitude/Longitude 42° 40' 07"; 76° 32' 16" 11.2 stream miles above mouth	[no photo available]
03	Forks of the Creek, New York Above Blakely Road bridge Latitude/Longitude 42° 37' 57"; 76° 32' 38" 8.0 stream miles above mouth	
04	Forks of the Creek, New York Above Salmon Creek Road bridge Latitude/Longitude 42° 37' 24"; 76° 32' 18" 7.2 stream miles above mouth	
05	Lansingville, New York Above Lockerby Hill Road bridge Latitude/Longitude 42° 35' 35"; 76° 32' 03" 4.6 stream miles above mouth	
06	Ludlowville, New York Off Mill Street Latitude/Longitude 42° 33' 12"; 76° 32' 00" 1.4 stream miles above mouth	

Figure 2	Site Overview Map	Salmon Creek

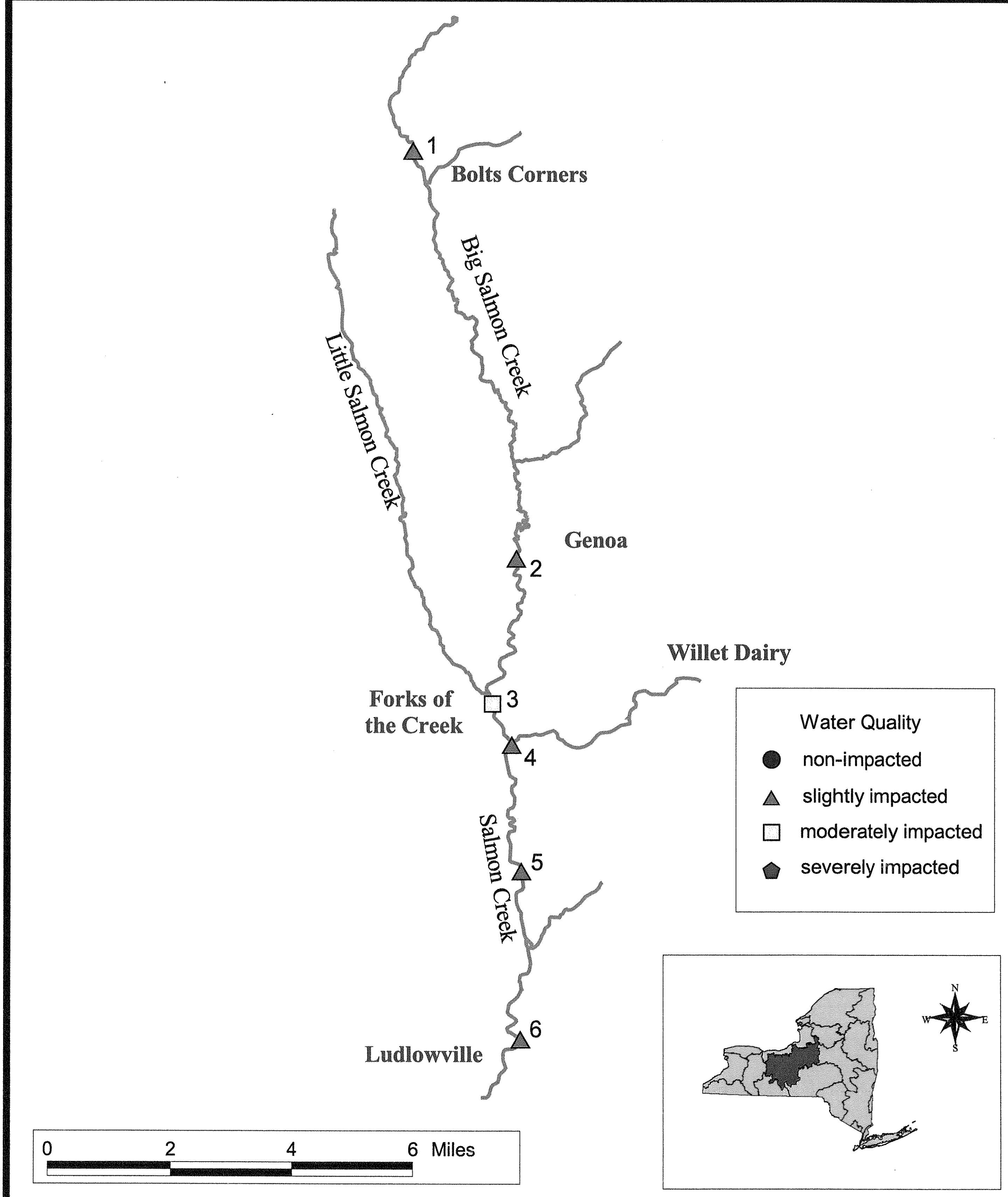
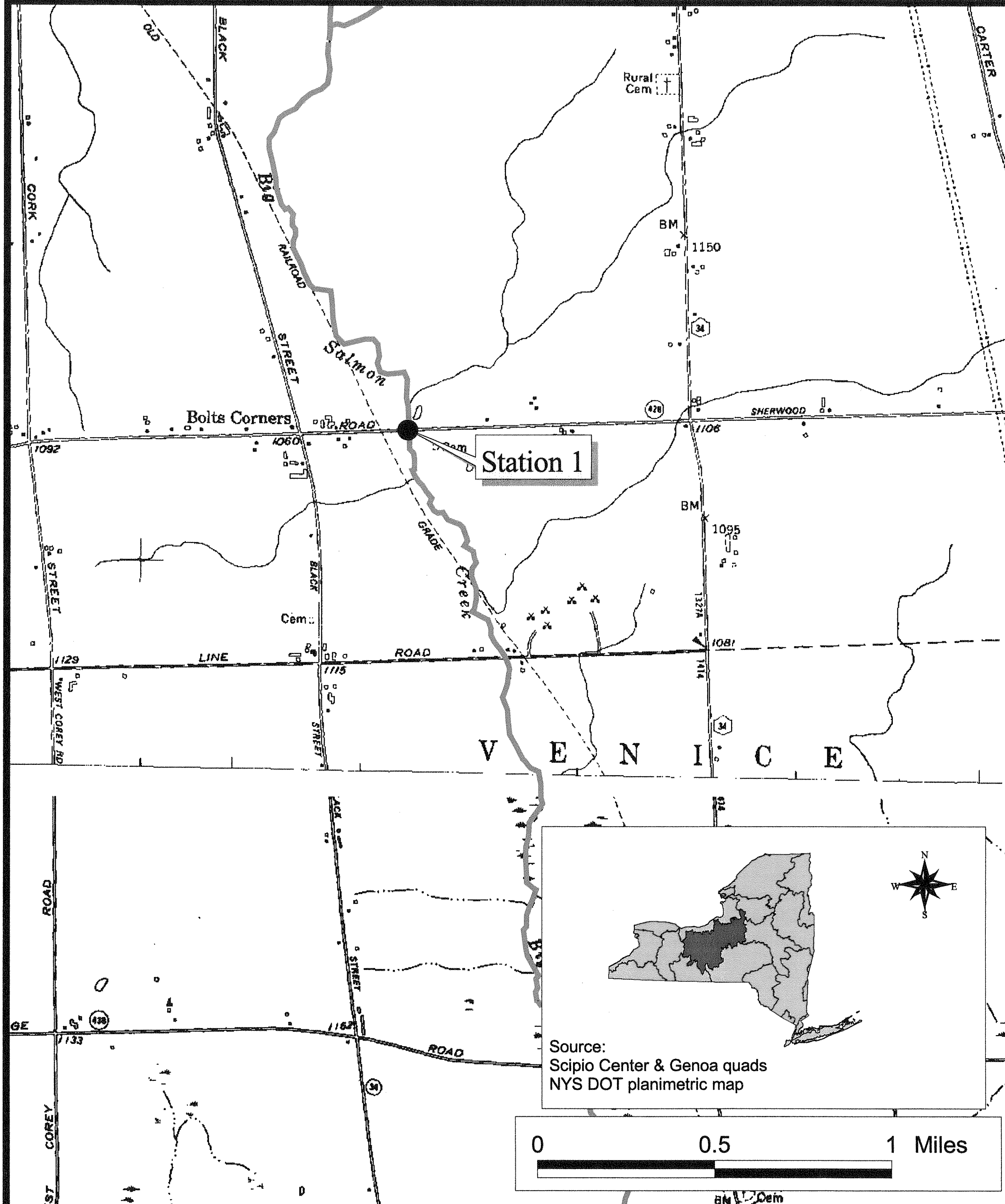
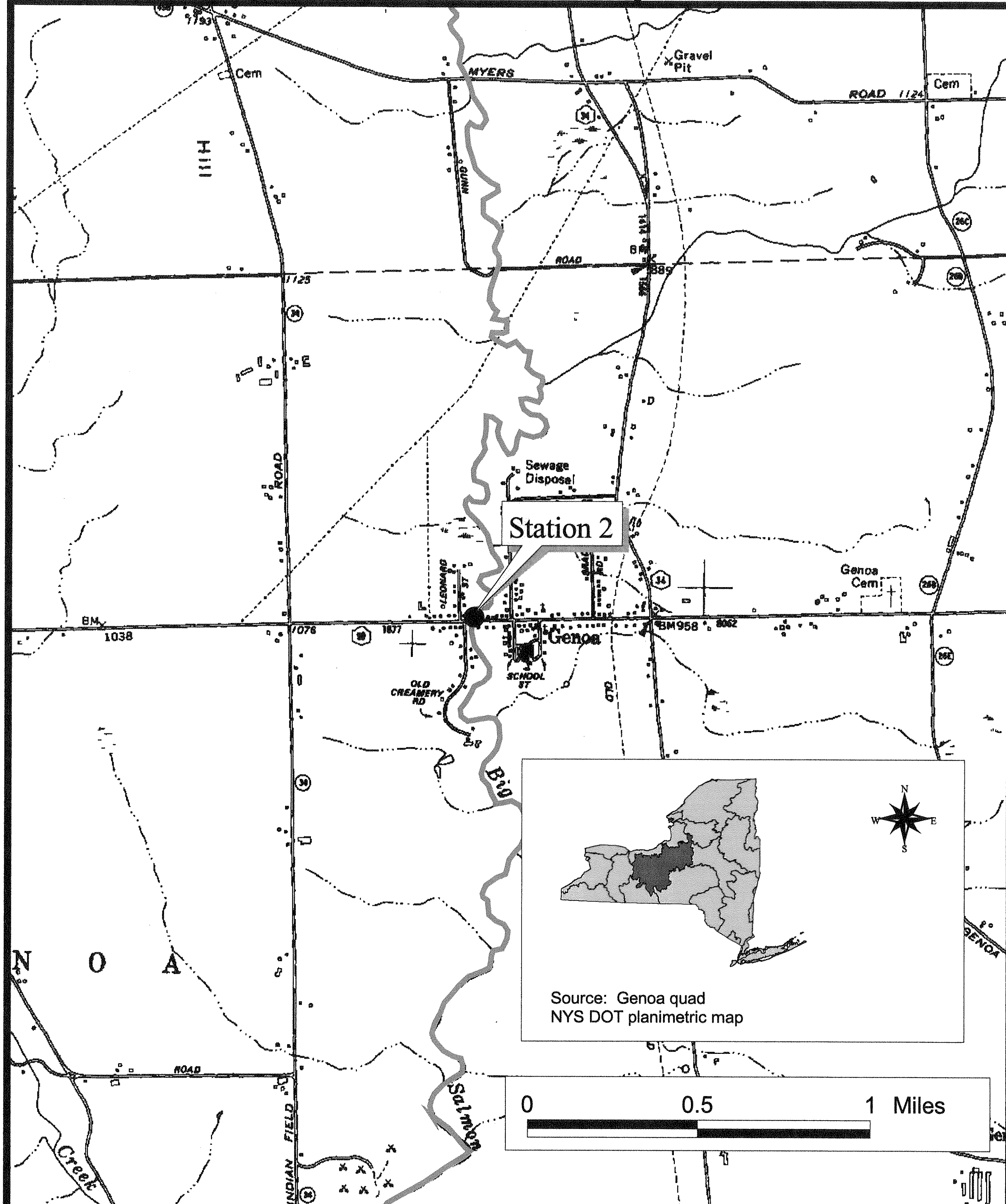


Figure 3a	Site Location Map	Big Salmon Creek



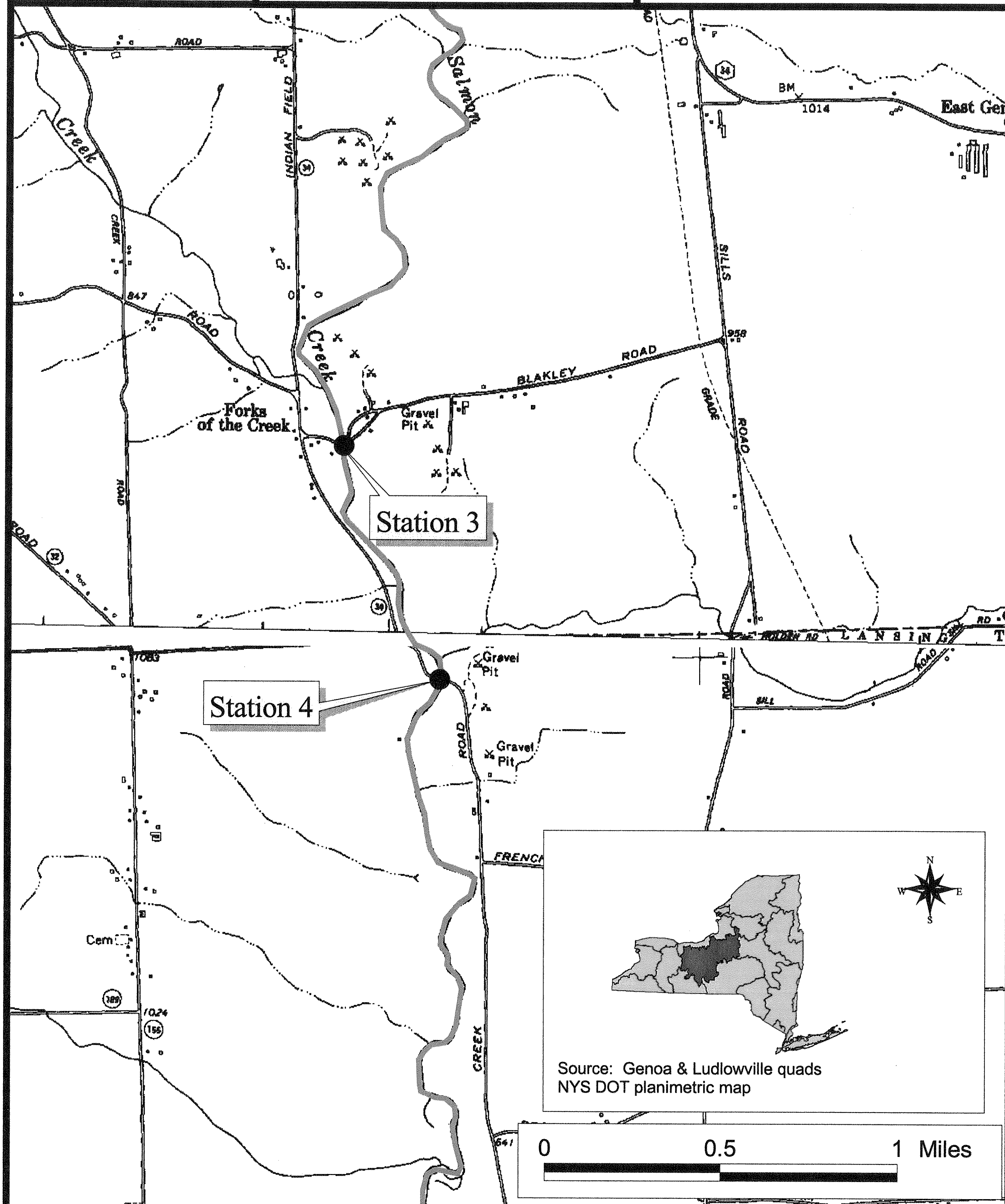
stream flow

Figure 3b	Site Location Map	Big Salmon Creek



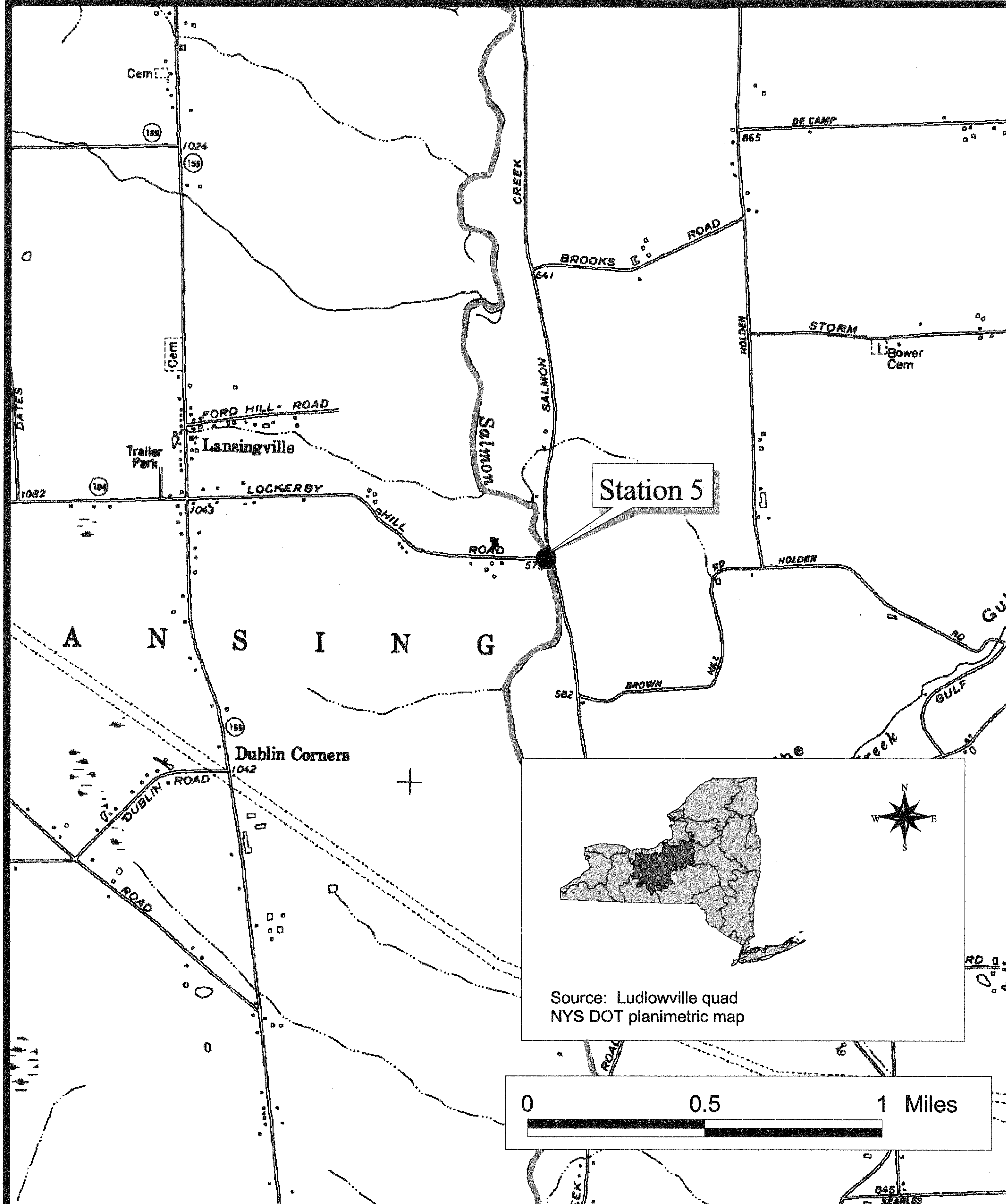
stream flow

Figure 3c	Site Location Map	Salmon Creek



stream flow

Figure 3d	Site Location Map	Salmon Creek



 ▼ stream flow

Figure 3e	Site Location Map	Salmon Creek

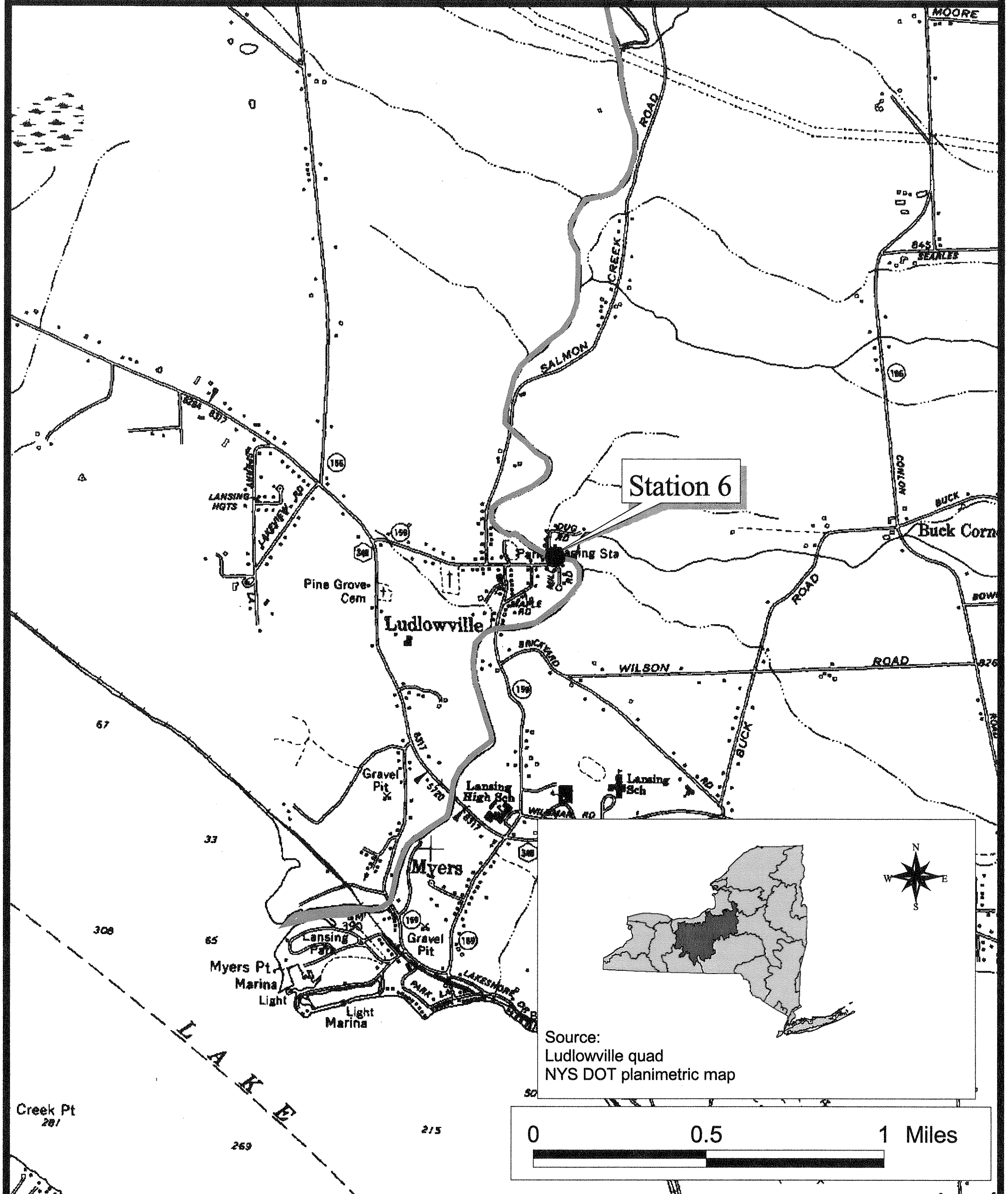


Table 3. Macroinvertebrate Species Collection in Salmon Creek, Cayuga County, New York, 2005.

OLIGOCHAETA
- LUMBRICIDA
  - Tubificidae
    - Undet. Lumbricina

ARTHROPODA
- INSECTA
  - EPHEMEROPTERA
    - Baetidae
      - *Baetis flavistriga*
      - *Baetis intercalaris*
      - *Centroptilum sp.*
    - Heptageniidae
      - *Stenonema* sp.
    - Leptohyphidae
      - *Tricorythodes* sp.

PLECOPTERA
- Pteronarcidae
  - *Pteronarcys biloba*

COLEOPTERA
- Psephenidae
  - *Psephenus herricki*
- Elmidae
  - *Dubiraphia bivittata*
  - *Optioservus fastiditus*
  - *Optioservus sp.*
  - *Stenelmis crenata*
  - *Stenelmis* sp.

MEGALOPTERA
- Sialidae
  - *Sialis* sp.

TRICHOPTERA
- Philopotamidae
  - *Chimarra obscura*
- Hydropsychidae
  - *Cheumatopsyche* sp.
  - *Hydropsyche betteni*
  - *Hydropsyche bronta*
  - *Hydropsyche slossonae*
  - *Hydropsyche sparna*
- Rhyacophilidae
  - *Rhyacophila fuscula*
- Hydroptilidae
  - *Hydroptila* sp.

DIPTERA
- Tipulidae
  - *Antocha sp.*
  - *Dicranota sp.*
  - *Hexatoma sp.*
- Ceratopogonidae
  - Undetermined Ceratopogonidae
- Simuliidae
  - *Simulium tuberosum*
  - *Simulium* sp.
- Empididae
  - *Hemerodromia* sp.
- Chironomidae
  - *Ablabesmyia mallochi*
  - *Thienemannimyia* gr. spp.
  - *Diamesa sp.*
  - *Pagastia orthogonia*
  - *Cardiocladius obscurus*
  - *Cricotopus bicinctus*
  - *Cricotopus tremulus gr.*
  - *Cricotopus trifascia* gr.
  - *Cricotopus vierriensis*
  - *Eukiefferiella brehmi gr.*
  - *Orthocladius nr. dentifer*
  - *Parametriocnemus lundbecki*
  - *Rheocricotopus robacki*
  - *Tvetenia vitracies*
  - *Demicryptochironomus sp.*
  - *Microtendipes pedellus* gr.
  - *Polypedilum aviceps*
  - *Polypedilum flavum*
  - *Rheotanytarsus exiguus gr.*
  - *Rheotanytarsus pellucidus*
  - *Sublettea coffmani*
  - *Tanytarsus glabrescens* gr.
  - *Tanytarsus guerlus gr.*

STREAM SITE:	Big Salmon Creek	SMON- 01
LOCATION:	Bolts Corners, NY,	below Sherwood Road
DATE:	26 July 2005	
SAMPLE TYPE:	Modified kick sample	
SUBSAMPLE:	100 organisms	

ANNELIDA			
OLIGOCHAETA			
LUMBRICIDA		Undetermined Lumbricina	1
ARTHROPODA			
INSECTA			
EPHEMEROPTERA	Baetidae	*Baetis flavistriga*	12
		Centroptilum sp.	1
COLEOPTERA	Elmidae	*Optioservus fastiditus*	10
TRICHOPTERA	Hydropsychidae	*Cheumatopsyche sp.*	10
		Hydropsyche betteni	4
		Hydropsyche bronta	5
DIPTERA	Tipulidae	*Dicranota sp.*	13
	Ceratopogonidae	Undetermined Ceratopogonidae	1
	Simuliidae	*Simulium sp.*	1
	Empididae	*Hemerodromia sp.*	4
	Chironomidae	*Thienemannimyia gr. spp.*	28
		Pagastia orthogonia	1
		Cricotopus tremulus gr.	1
		Polypedilum aviceps	3
		Polypedilum flavum	5

SPECIES RICHNESS:	16 (poor)
BIOTIC INDEX:	4.96 (good)
EPT RICHNESS:	5 (poor)
MODEL AFFINITY:	64 (good)
ASSESSMENT:	slightly impacted (5.83)

DESCRIPTION: The sample was taken downstream of Sherwood Road, near Bolts Corners. The stream was very small at this point, with low flow, and a modified kick sample was used, in which water, sediments, and benthos are pushed by foot into the net. The fauna was dominated by midges, and water quality was assessed as slightly impacted.

STREAM SITE:	Big Salmon Creek	SMON- 02
LOCATION:	Genoa, NY,	above Route 90
DATE:	26 July 2005	
SAMPLE TYPE:	Kick sample	
SUBSAMPLE:	100 organisms	

ANNELIDA			
OLIGOCHAETA			
LUMBRICIDA		Undetermined Lumbricina	1
ARTHROPODA			
INSECTA			
EPHEMEROPTERA	Baetidae	*Baetis flavistriga*	3
COLEOPTERA	Elmidae	*Dubiraphia bivittata*	3
		Optioservus sp.	2
		Stenelmis sp.	1
TRICHOPTERA	Philopotamidae	*Chimarra obscura*	4
	Hydropsychidae	*Cheumatopsyche sp.*	3
		Hydropsyche betteni	9
		Hydropsyche bronta	34
DIPTERA	Chironomidae	*Thienemannimyia gr. spp.*	5
		Pagastia orthogonia	2
		Cricotopus bicinctus	6
		Cricotopus tremulus gr.	3
		Eukiefferiella brehmi gr.	1
		Rheocricotopus robacki	1
		Microtendipes pedellus gr.	1
		Polypedilum aviceps	4
		Polypedilum flavum	13
		Rheotanytarsus pellucidus	1
		Sublettea coffmani	1
		Tanytarsus glabrescens gr.	1
		Tanytarsus guerlus gr.	1

SPECIES RICHNESS:	22 (good)
BIOTIC INDEX:	5.71 (good)
EPT RICHNESS:	5 (poor)
MODEL AFFINITY:	40 (poor)
ASSESSMENT:	slightly impacted (5.09)

DESCRIPTION: The stream flow was much greater at this site than at Station 1due to many tributaries entering between the sites. The rocks in the stream bottom were coated with algae and silt. Caddisflies and midges dominated the macroinvertebrate community, and water quality was assessed as slightly impacted.

STREAM SITE:	Salmon Creek	SMON- 03	
LOCATION:	East Genoa, NY,	Blakely Road	
DATE:	26 July 2005		
SAMPLE TYPE:	Kick sample		
SUBSAMPLE:	100 organisms		

ANNELIDA			
OLIGOCHAETA			
LUMBRICIDA		Undetermined Lumbricina	2
ARTHROPODA			
INSECTA			
EPHEMEROPTERA	Heptageniidae	*Stenonema sp.*	6
COLEOPTERA	Elmidae	*Optioservus fastiditus*	4
TRICHOPTERA	Hydropsychidae	*Cheumatopsyche sp.*	3
		Hydropsyche bronta	40
DIPTERA	Tipulidae	*Dicranota sp.*	1
		Antocha sp.	2
	Empididae	*Hemerodromia sp.*	6
	Chironomidae	*Thienemannimyia gr. spp.*	23
		Pagastia orthogonia	6
		Tvetenia vitracies	2
		Demicryptochironomus sp.	1
		Microtendipes pedellus gr.	1
		Polypedilum aviceps	2
		Tanytarsus guerlus gr.	1

SPECIES RICHNESS:	15 (poor)
BIOTIC INDEX:	5.28 (good)
EPT RICHNESS:	3 (poor)
MODEL AFFINITY:	51 (good)
ASSESSMENT:	moderately impacted (4.86)

DESCRIPTION: This site is approximately 0.2 miles downstream of the confluence of Big Salmon Creek and Little Salmon Creek. As at Station 2, stream rocks were covered with filamentous algae and silt, and the macroinvertebrate community was dominated by caddisflies and midges. Due to a drop in species richness from Station 2, water quality fell within the range of moderate impact.

STREAM SITE:	Salmon Creek	SMON- 04	
LOCATION:	East Genoa, NY,	above Salmon Creek Road	
DATE:	26 July 2005		
SAMPLE TYPE:	Kick sample		
SUBSAMPLE:	100 organisms		

ARTHROPODA			
INSECTA			
EPHEMEROPTERA	Baetidae	*Baetis flavistriga*	7
	Heptageniidae	*Stenonema sp.*	2
COLEOPTERA	Elmidae	*Stenelmis sp.*	3
TRICHOPTERA	Hydropsychidae	*Cheumatopsyche sp.*	2
		Hydropsyche betteni	3
		Hydropsyche bronta	18
		Hydropsyche sparna	4
	Hydroptilidae	*Hydroptila sp.*	2
DIPTERA	Tipulidae	*Dicranota sp.*	2
	Simuliidae	*Simulium tuberosum*	1
	Chironomidae	*Ablabesmyia mallochi*	1
		Thienemannimyia gr. spp.	8
		Diamesa sp.	1
		Cricotopus trifascia gr.	24
		Cricotopus vierriensis	4
		Orthocladius nr. dentifer	1
		Tvetenia vitracies	2
		Microtendipes pedellus gr.	1
		Polypedilum flavum	14

SPECIES RICHNESS:	19 (good)
BIOTIC INDEX:	5.73 (good)
EPT RICHNESS:	7 (good)
MODEL AFFINITY:	45 (poor)
ASSESSMENT:	slightly impacted (5.36)

DESCRIPTION: This site was approximately 100 meters downstream of the tributary that receives runoff from Willet Dairy. The creek appeared to have more algae than at Station 3, but the macroinvertebrate community had higher species richness, and was assessed as slightly impacted. Midges and caddisflies continued to dominate the fauna.

STREAM SITE:	Salmon Creek	SMON- 05	
LOCATION:	Lansingville, NY,	above Lockerby Hill Road	
DATE:	26 July 2005		
SAMPLE TYPE:	Kick sample		
SUBSAMPLE:	100 organisms		

ANNELIDA			
OLIGOCHAETA			
LUMBRICIDA		Undetermined Lumbricina	1
ARTHROPODA			
INSECTA			
EPHEMEROPTERA	Baetidae	*Baetis flavistriga*	8
		Baetis intercalaris	1
	Heptageniidae	*Stenonema sp.*	7
	Leptohyphidae	*Tricorythodes sp.*	2
MEGALOPTERA	Sialidae	*Sialis sp.*	1
TRICHOPTERA	Hydropsychidae	*Hydropsyche bronta*	12
		Hydropsyche slossonae	2
		Hydropsyche sparna	18
	Hydroptilidae	*Hydroptila sp.*	5
DIPTERA	Empididae	*Hemerodromia sp.*	1
	Chironomidae	*Thienemannimyia gr. spp.*	9
		Cricotopus bicinctus	3
		Cricotopus trifascia gr.	9
		Cricotopus vierriensis	4
		Orthocladius nr. dentifer	1
		Parametriocnemus lundbecki	1
		Tvetenia vitracies	1
		Polypedilum aviceps	1
		Polypedilum flavum	13

SPECIES RICHNESS:	20 (good)
BIOTIC INDEX:	5.55 (good)
EPT RICHNESS:	8 (good)
MODEL AFFINITY:	51 (good)
ASSESSMENT:	slightly impacted (5.87)

DESCRIPTION: Algae was very prominent on the stream bottom, but all macroinvertebrate metrics improved slightly compared to Station 4. Midges and caddisflies continued to dominate the macroinvertebrate community, and water quality was assessed as slightly impacted.

STREAM SITE:	Salmon Creek	SMON- 06	
LOCATION:	Ludlowville, NY,	off Mill Street	
DATE:	26 July 2005		
SAMPLE TYPE:	Kick sample		
SUBSAMPLE:	100 organisms		

ANNELIDA			
OLIGOCHAETA			
LUMBRICIDA		Undetermined Lumbricina	2
ARTHROPODA			
INSECTA			
EPHEMEROPTERA	Baetidae	*Baetis flavistriga*	4
PLECOPTERA	Pteronarcidae	*Pteronarcys biloba*	1
COLEOPTERA	Psephenidae	*Psephenus herricki*	1
	Elmidae	*Optioservus fastiditus*	2
		Stenelmis crenata	2
TRICHOPTERA	Hydropsychidae	*Cheumatopsyche sp.*	3
		Hydropsyche bronta	26
		Hydropsyche slossonae	4
		Hydropsyche sparna	15
	Rhyacophilidae	*Rhyacophila fuscula*	1
	Hydroptilidae	*Hydroptila sp.*	1
DIPTERA	Tipulidae	*Hexatoma sp.*	8
	Empididae	*Hemerodromia sp.*	1
	Chironomidae	*Thienemannimyia gr. spp.*	18
		Diamesa sp.	6
		Cricotopus trifascia gr.	1
		Tvetenia vitracies	1
		Microtendipes pedellus gr.	2
		Rheotanytarsus exiguus gr.	1

SPECIES RICHNESS:	20 (good)
BIOTIC INDEX:	5.22 (good)
EPT RICHNESS:	8 (good)
MODEL AFFINITY:	51 (good)
ASSESSMENT:	slightly impacted (5.97)

DESCRIPTION: The stream bottom was mostly bedrock at this site, but small areas of rubble were found, and these were sampled. Macroinvertebrate community metrics were very similar to those at Station 5, and water quality was similarly assessed as slightly impacted. Stoneflies of the family Pteronarcidae, considered indicators of very good water quality, were found at this site.

FIELD DATA SUMMARY				
STREAM NAME: Salmon Creek	DATE SAMPLED: 7/26 & 27/2005			
REACH: Bolts Corners to Ludlowville				
FIELD PERSONNEL INVOLVED: Bode, Heitzman				
STATION	01	02	03	04
ARRIVAL TIME AT STATION	03:30	02:45	08:45	09:15
LOCATION	Bolts Corners	Genoa	Forks of the Creek	Below Forks of the Creek
PHYSICAL CHARACTERISTICS				
Width (meters)	1.0	6.0	8.0	10
Depth (meters)	0.1	0.1	0.1	0.1
Current speed (cm per sec.)	40	60	75	100
Substrate (%)				
Rock (>25.4 cm, or bedrock)		10	10	10
Rubble (6.35 – 25.4 cm)	40	30	40	40
Gravel (0.2 – 6.35 cm)	20	20	20	20
Sand (0.06 – 2.0 mm)	20	10	10	10
Silt (0.004 – 0.06 mm)	20	30	20	20
Embeddedness (%)	20	40	40	40
CHEMICAL MEASUREMENTS				
Temperature (° C)	22.4	24.5	21.6	22.5
Specific Conductance (umhos)	652	592	365	499
Dissolved Oxygen (mg/l)	7.8	10.0	8.3	8.2
pH	7.7	8.1	7.8	7.8
BIOLOGICAL ATTRIBUTES				
Canopy (%)	50	20	20	20
Aquatic Vegetation				
algae – suspended				
algae – attached, filamentous	X	X	X	XXXXX
algae – diatoms	X	X	X	X
macrophytes or moss				
Occurrence of Macroinvertebrates				
Ephemeroptera (mayflies)		X	X	X
Plecoptera (stoneflies)				
Trichoptera (caddisflies)	X	X	X	X
Coleoptera (beetles)	X	X	X	
Megaloptera (dobsonflies, alderflies)				
Odonata (dragonflies, damselflies)				
Chironomidae (midges)	X		X	X
Simuliidae (black flies)				
Decapoda (crayfish)	X	X		
Gammaridae (scuds)				
Mollusca (snails, clams)				
Oligochaeta (worms)			X	
Other				
FAUNAL CONDITION	Good	Good	Good	Good

FIELD DATA SUMMARY

STREAM NAME: Salmon Creek	DATE SAMPLED: 7/26 & 27/2005			
REACH: Bolts Corners to Ludlowville				
FIELD PERSONNEL INVOLVED: Bode, Heitzman				
STATION	05	06		
ARRIVAL TIME AT STATION	09:45	10:15		
LOCATION	Lansingville	Ludlowville		
PHYSICAL CHARACTERISTICS				
Width (meters)	8.0	8.0		
Depth (meters)	0.1	0.1		
Current speed (cm per sec.)	90	90		
Substrate (%)				
Rock (>25.4 cm, or bedrock)		20		
Rubble (6.35 – 25.4 cm)	40	30		
Gravel (0.2 – 6.35 cm)	20	20		
Sand (0.06 – 2.0 mm)	10	10		
Silt (0.004 – 0.06 mm)	30	20		
Embeddedness (%)	20	20		
CHEMICAL MEASUREMENTS				
Temperature (°C)	20.9	23.0		
Specific Conductance (umhos)	495	527		
Dissolved Oxygen (mg/l)	11.1	9.9		
pH	8.0	8.2		
BIOLOGICAL ATTRIBUTES				
Canopy (%)	20	10		
Aquatic Vegetation				
algae – suspended				
algae – attached, filamentous	XX	X		
algae – diatoms	X	X		
macrophytes or moss				
Occurrence of Macroinvertebrates				
Ephemeroptera (mayflies)	X	X		
Plecoptera (stoneflies)	X	X		
Trichoptera (caddisflies)	X	X		
Coleoptera (beetles)		X		
Megaloptera (dobsonflies, alderflies)				
Odonata (dragonflies, damselflies)				
Chironomidae (midges)	X			
Simuliidae (black flies)				
Decapoda (crayfish)		X		
Gammaridae (scuds)				
Mollusca (snails, clams)				
Oligochaeta (worms)	X			
Other				
FAUNAL CONDITION	Good	Good		

LABORATORY DATA SUMMARY

STREAM NAME: Salmon Creek	**DRAINAGE: 07**
DATE SAMPLED: 07/26/2005	**COUNTY: Cayuga & Tompkins**

SAMPLING METHOD: Travelling Kick

STATION	01	02	03	04
LOCATION	Bolts Corners	Genoa	Forks of the Creek	Below Forks of the Creek
DOMINANT SPECIES/%CONTRIBUTION/TOLERANCE/COMMON NAME				
1.	Thienemannimyia gr. spp.	Hydropsyche bronta	Hydropsyche bronta	Cricotopus trifascia gr.
	28 %	34 %	40 %	24 %
	facultative	facultative	facultative	facultative
	midge	caddisfly	caddisfly	midge
2.	Dicranota sp.	Polypedilum flavum	Thienemannimyia gr. spp.	Hydropsyche bronta
Intolerant = not tolerant of poor	13 %	13 %	23 %	18 %
water quality	intolerant	facultative	facultative	facultative
	crane fly	midge	midge	caddisfly
3.	Baetis flavistriga	Hydropsyche betteni	Stenonema sp.	Polypedilum flavum
Facultative = occurring over a	12 %	9 %	6 %	14 %
wide range of water quality	intolerant	facultative	intolerant	facultative
	mayfly	caddisfly	mayfly	midge
4.	Optioservus fastiditus	Cricotopus bicinctus	Hemerodromia sp.	Thienemannimyia gr. spp.
Tolerant = tolerant of poor	10 %	6 %	6 %	8 %
water quality	intolerant	tolerant	tolerant	facultative
	beetle	midge	diptera	midge
5.	Cheumatopsyche sp.	Thienemannimyia gr. spp.	Pagastia orthogonia	Baetis flavistriga
	10 %	5 %	6 %	7 %
	facultative	facultative	intolerant	intolerant
	caddisfly	midge	midge	mayfly
% CONTRIBUTION OF MAJOR GROUPS (NUMBER OF TAXA IN PARENTHESES)				
Chironomidae (midges)	38.0 (5.0)	40.0 (13.0)	36.0 (7.0)	56.0 (9.0)
Trichoptera (caddisflies)	19.0 (3.0)	50.0 (4.0)	43.0 (2.0)	29.0 (5.0)
Ephemeroptera (mayflies)	13.0 (2.0)	3.0 (1.0)	6.0 (1.0)	9.0 (2.0)
Plecoptera (stoneflies)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
Coleoptera (beetles)	10.0 (1.0)	6.0 (3.0)	4.0 (1.0)	3.0 (1.0)
Oligochaeta (worms)	1.0 (1.0)	1.0 (1.0)	2.0 (1.0)	0.0 (0.0)
Mollusca (clams and snails)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
Crustacea (crayfish, scuds, sowbugs)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
Other insects (odonates, diptera)	19.0 (4.0)	0.0 (0.0)	9.0 (3.0)	3.0 (2.0)
Other (Nemertea, Platyhelminthes)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
SPECIES RICHNESS	16	22	15	19
BIOTIC INDEX	4.96	5.71	5.28	5.73
EPT RICHNESS	5	5	3	7
PERCENT MODEL AFFINITY	64	40	51	45
FIELD ASSESSMENT	Good	Good	Good	Good
OVERALL ASSESSMENT	Slight	Slight	Moderate	Slight

LABORATORY DATA SUMMARY				
STREAM NAME: Salmon Creek		**DRAINAGE: 07**		
DATE SAMPLED: 07/26/2005		**COUNTY: Cayuga & Tompkins**		
SAMPLING METHOD: Travelling Kick				
STATION	05	06		
LOCATION	Lansingville	Ludlowville		
DOMINANT SPECIES/%CONTRIBUTION/TOLERANCE/COMMON NAME				
1.	Hydropsyche sparna	Hydropsyche bronta		
	18 %	26 %		
	facultative	facultative		
	caddisfly	caddisfly		
2.	Polypedilum flavum	Thienemannimyia gr. spp.		
Intolerant = not tolerant of poor	13 %	18 %		
water quality	facultative	facultative		
	midge	midge		
3.	Hydropsyche bronta	Hydropsyche sparna		
Facultative = occurring over a	12 %	15 %		
wide range of water quality	facultative	facultative		
	caddisfly	caddisfly		
4.	Thienemannimyia gr. spp.	Hexatoma sp.		
Tolerant = tolerant of poor	9 %	8 %		
water quality	facultative	intolerant		
	midge	crane fly		
5.	Cricotopus trifascia gr.	Diamesa sp.		
	9 %	6 %		
	facultative	facultative		
	midge	midge		
% CONTRIBUTION OF MAJOR GROUPS (NUMBER OF TAXA IN PARENTHESES)				
Chironomidae (midges)	42.0 (9.0)	29.0 (6.0)		
Trichoptera (caddisflies)	37.0 (4.0)	50.0 (6.0)		
Ephemeroptera (mayflies)	18.0 (4.0)	4.0 (1.0)		
Plecoptera (stoneflies)	0.0 (0.0)	1.0 (1.0)		
Coleoptera (beetles)	0.0 (0.0)	5.0 (3.0)		
Oligochaeta (worms)	1.0 (1.0)	2.0 (1.0)		
Mollusca (clams and snails)	0.0 (0.0)	0.0 (0.0)		
Crustacea (crayfish, scuds, sowbugs)	0.0 (0.0)	1.0 (1.0)		
Other insects (odonates, diptera)	2.0 (2.0)	9.0 (2.0)		
Other (Nemertea, Platyhelminthes)	0.0 (0.0)	0.0 (0.0)		
SPECIES RICHNESS	20	20		
BIOTIC INDEX	5.55	5.22		
EPT RICHNESS	8	8		
PERCENT MODEL AFFINITY	51	51		
FIELD ASSESSMENT	Good	Good		
OVERALL ASSESSMENT	Slight	Slight		

Appendix I. Biological Methods for Kick Sampling

A. Rationale. The use of the standardized kick sampling method provides a biological assessment technique that lends itself to rapid assessments of stream water quality.

B. Site Selection. Sampling sites are selected based on these criteria: (1) The sampling location should be a riffle with a substrate of rubble, gravel, and sand. Depth should be one meter or less, and current speed should be at least 0.4 meters per second. (2) The site should have comparable current speed, substrate type, embeddedness, and canopy cover to both upstream and downstream sites to the degree possible. (3) Sites are chosen to have a safe and convenient access.

C. Sampling. Macroinvertebrates are sampled using the standardized traveling kick method. An aquatic net is positioned in the water at arms' length downstream and the stream bottom is disturbed by foot, so that organisms are dislodged and carried into the net. Sampling is continued for a specified time and distance in the stream. Rapid assessment sampling specifies sampling for five minutes over a distance of five meters. The contents of the net are emptied into a pan of stream water. The contents are then examined, and the major groups of organisms are recorded, usually on the ordinal level (e.g., stoneflies, mayflies, caddisflies). Larger rocks, sticks, and plants may be removed from the sample if organisms are first removed from them. The contents of the pan are poured into a U.S. No. 30 sieve and transferred to a quart jar. The sample is then preserved by adding 95% ethyl alcohol.

D. Sample Sorting and Subsampling. In the laboratory, the sample is rinsed with tap water in a U.S. No. 40 standard sieve to remove any fine particles left in the residues from field sieving. The sample is transferred to an enamel pan and distributed homogeneously over the bottom of the pan. A small amount of the sample is randomly removed with a spatula, rinsed with water, and placed in a petri dish. This portion is examined under a dissecting stereomicroscope and 100 organisms are randomly removed from the debris. As they are removed, they are sorted into major groups, placed in vials containing 70 percent alcohol, and counted. The total number of organisms in the sample is estimated by weighing the residue from the picked subsample and determining its proportion of the total sample weight.

E. Organism Identification. All organisms are identified to the species level whenever possible. Chironomids and oligochaetes are slide-mounted and viewed through a compound microscope; most other organisms are identified as whole specimens using a dissecting stereomicroscope. The number of individuals in each species, and the total number of individuals in the subsample is recorded on a data sheet. All organisms from the subsample are archived (either slide-mounted or preserved in alcohol). If the results of the identification process are ambiguous, suspected of being spurious, or do not yield a clear water quality assessment, additional subsampling may be required.

Appendix II. Macroinvertebrate Community Parameters

1. Species Richness is the total number of species or taxa found in the sample. For subsamples of 100-organisms each that are taken from kick samples, expected ranges in most New York State streams are: greater than 26, non-impacted; 19-26, slightly impacted; 11-18, moderately impacted; less than 11, severely impacted.

2. EPT Richness denotes the total number of species of mayflies (Ephemeroptera), stoneflies (Plecoptera), and caddisflies (Trichoptera) found in an average 100-organisms subsample. These are considered to be clean-water organisms, and their presence is generally correlated with good water quality (Lenat, 1987). Expected assessment ranges from most New York State streams are: greater than 10, non-impacted; 6-10, slightly impacted; 2-5, moderately impacted; and 0-1, severely impacted.

3. Hilsenhoff Biotic Index is a measure of the tolerance of organisms in a sample to organic pollution (sewage effluent, animal wastes) and low dissolved oxygen levels. It is calculated by multiplying the number of individuals of each species by its assigned tolerance value, summing these products, and dividing by the total number of individuals. On a 0-10 scale, tolerance values range from intolerant (0) to tolerant (10). For the purpose of characterizing species' tolerance, intolerant = 0-4, facultative = 5-7, and tolerant = 8-10. Tolerance values are listed in Hilsenhoff (1987). Additional values are assigned by the NYS Stream Biomonitoring Unit. The most recent values for each species are listed in Quality Assurance document, Bode et al. (1996). Impact ranges are: 0-4.50, non-impacted; 4.51-6.50, slightly impacted; 6.51-8.50, moderately impacted; and 8.51-10.00, severely impacted.

4. Percent Model Affinity is a measure of similarity to a model, non-impacted community based on percent abundance in seven major macroinvertebrate groups (Novak and Bode, 1992). Percent abundances in the model community are: 40% Ephemeroptera; 5% Plecoptera; 10% Trichoptera; 10% Coleoptera; 20% Chironomidae; 5% Oligochaeta; and 10% Other. Impact ranges are: greater than 64, non-impacted; 50-64, slightly impacted; 35-49, moderately impacted; and less than 35, severely impacted.

Bode, R.W., M.A. Novak, and L.E. Abele. 1996. Quality assurance work plan for biological stream monitoring in New York State. NYSDEC Technical Report, 89 pages.

Hilsenhoff, W. L. 1987. An improved biotic index of organic stream pollution. The Great Lakes Entomologist 20(1): 31-39.

Lenat, D. R. 1987. Water quality assessment using a new qualitative collection method for freshwater benthic macroinvertebrates. North Carolina Division of Environmental Management Technical Report. 12 pages.

Novak, M.A., and R.W. Bode. 1992. Percent model affinity: a new measure of macroinvertebrate community composition. J. N. Am. Benthol. Soc. 11(1): 80-85.

Appendix III. Levels of Water Quality Impact in Streams

The description of overall stream water quality based on biological parameters uses a four-tiered system of classification. Level of impact is assessed for each individual parameter and then combined for all parameters to form a consensus determination. Four parameters are used: species richness, EPT richness, biotic index, and percent model affinity (see Appendix II). The consensus is based on the determination of the majority of the parameters. Since parameters measure different aspects of the macroinvertebrate community, they cannot be expected to always form unanimous assessments. The assessment ranges given for each parameter are based on subsamples of 100-organisms each that are taken from macroinvertebrate riffle kick samples. These assessments also apply to most multiplate samples, with the exception of percent model affinity.

1. _Non-impacted_ Indices reflect very good water quality. The macroinvertebrate community is diverse, usually with at least 27 species in riffle habitats. Mayflies, stoneflies, and caddisflies are well-represented; the EPT richness is greater than 10. The biotic index value is 4.50 or less. Percent model affinity is greater than 64. Water quality should not be limiting to fish survival or propagation. This level of water quality includes both pristine habitats and those receiving discharges which minimally alter the biota.

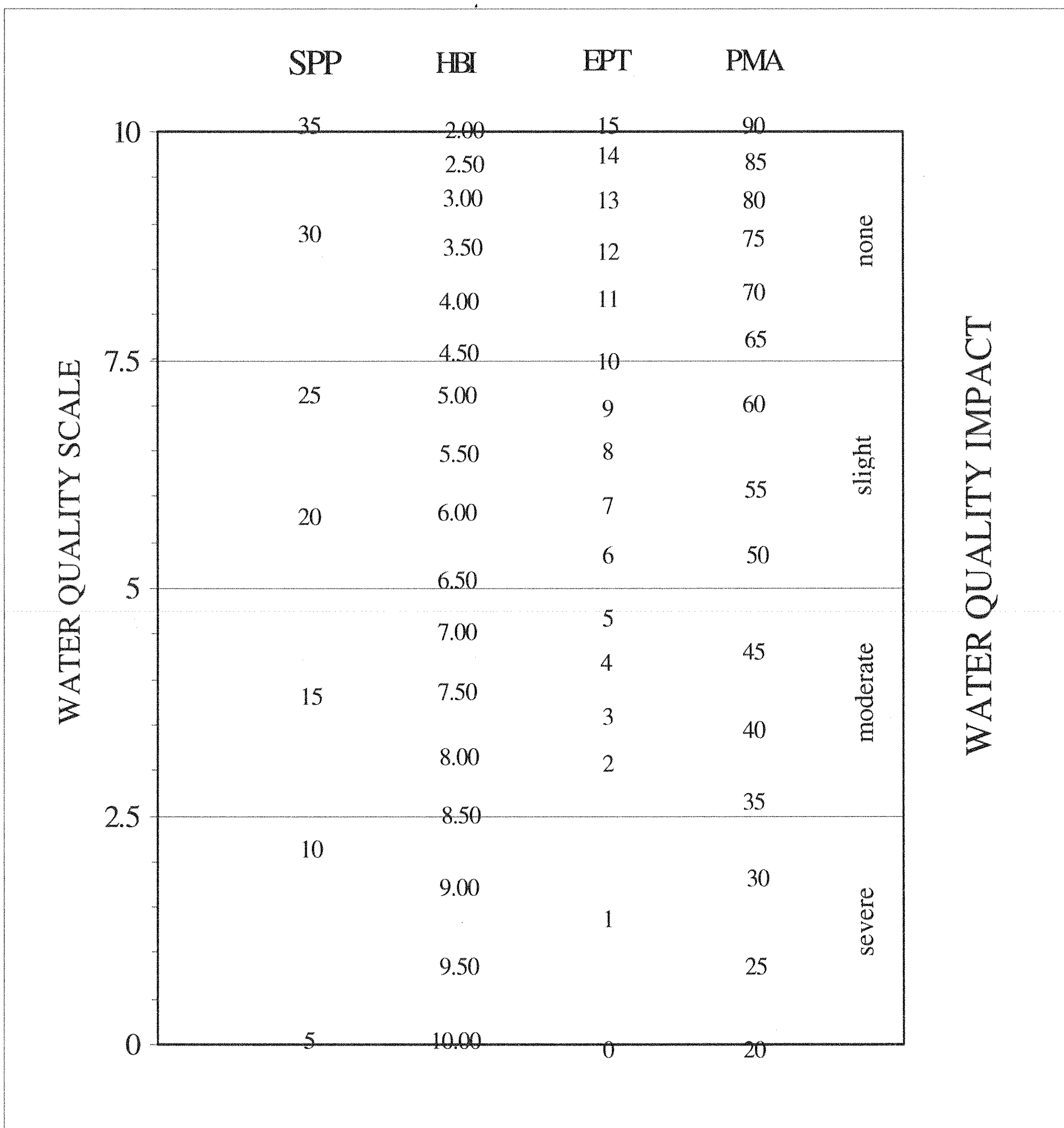
2. _Slightly impacted_ Indices reflect good water quality. The macroinvertebrate community is slightly but significantly altered from the pristine state. Species richness usually is 19-26. Mayflies and stoneflies may be restricted, with EPT richness values of 6-10. The biotic index value is 4.51-6.50. Percent model affinity is 50-64. Water quality is usually not limiting to fish survival, but may be limiting to fish propagation.

3. _Moderately impacted_ Indices reflect poor water quality. The macroinvertebrate community is altered to a large degree from the pristine state. Species richness usually is 11-18 species. Mayflies and stoneflies are rare or absent, and caddisflies are often restricted; the EPT richness is 2-5. The biotic index value is 6.51-8.50. The percent model affinity value is 35-49. Water quality often is limiting to fish propagation, but usually not to fish survival.

4. _Severely impacted_ Indices reflect very poor water quality. The macroinvertebrate community is limited to a few tolerant species. Species richness is 10 or less. Mayflies, stoneflies, and caddisflies are rare or absent; EPT richness is 0-1. The biotic index value is greater than 8.50. Percent model affinity is less than 35. The dominant species are almost all tolerant, and are usually midges and worms. Often 1-2 species are very abundant. Water quality is often limiting to both fish propagation and fish survival.

Appendix IV-A. Biological Assessment Profile: Conversion of Index Values to Common 10-Scale

The Biological Assessment Profile of index values, developed by Phil O'Brien, Division of Water, NYSDEC, is a method of plotting biological index values on a common scale of water quality impact. Values from the four indices defined in Appendix II are converted to a common 0-10 scale using the formulae in the Quality Assurance document (Bode, 2002), and as shown in the figure below.



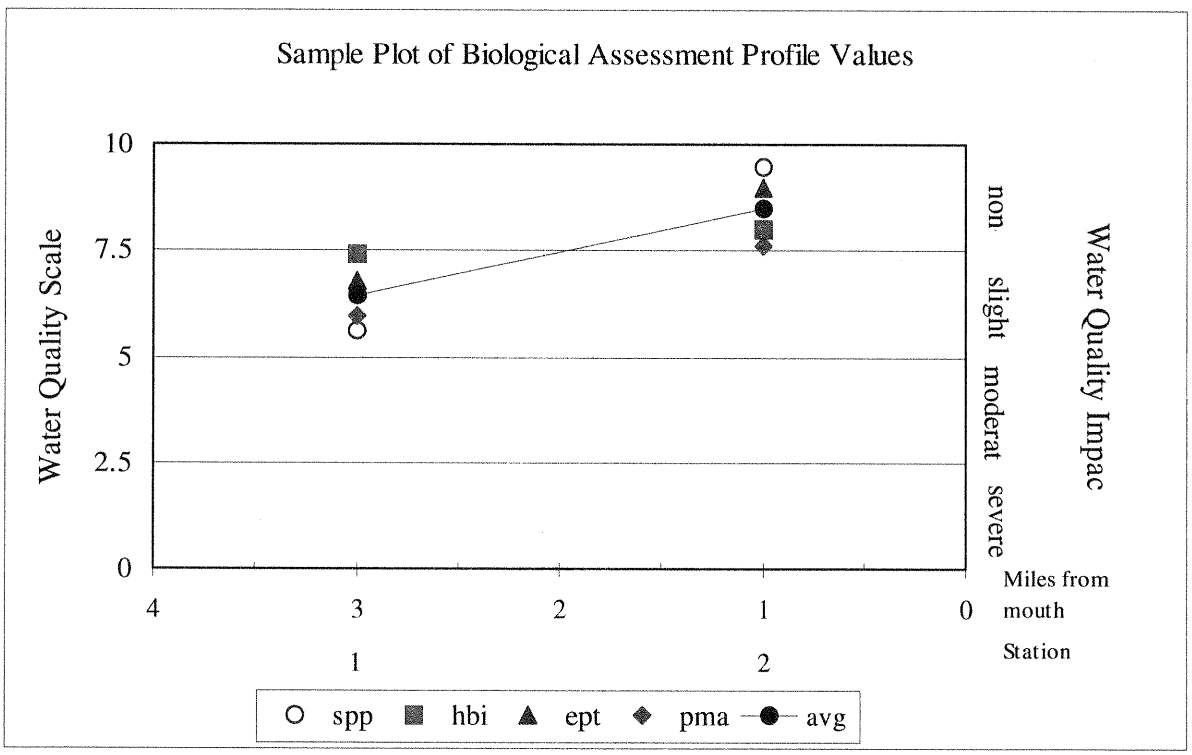
Appendix IV-B. Biological Assessment Profile: Plotting Values

To plot survey data:
1. Position each site on the x-axis according to miles or tenths of a mile upstream of the mouth.
2. Plot the values of the four indices for each site as indicated by the common scale.
3. Calculate the mean of the four values and plot the result. This represents the assessed impact for each site.

Example data:

	Station 1		Station 2	
	metric value	10-scale value	metric value	10-scale value
Species richness	20	5.59	33	9.44
Hilsenhoff biotic index	5.00	7.40	4.00	8.00
EPT richness	9	6.80	13	9.00
Percent model affinity	55	5.97	65	7.60
Average		6.44 (slight)		8.51 (non-)

Table IV-B. Sample Plot of Biological Assessment Profile values



Appendix V. Water Quality Assessment Criteria

Water Quality Assessment Criteria for Non-Navigable Flowing Waters

	Species Richness	Hilsenhoff Biotic Index	EPT Richness	Percent Model Affinity#	Species Diversity*
Non-Impacted	>26	0.00-4.50	>10	>64	>4
Slightly Impacted	19-26	4.51-6.50	6-10	50-64	3.01-4.00
Moderately Impacted	11-18	6.51-8.50	2-5	35-49	2.01-3.00
Severely Impacted	0-10	8.51-10.00	0-1	<35	0.00-2.00

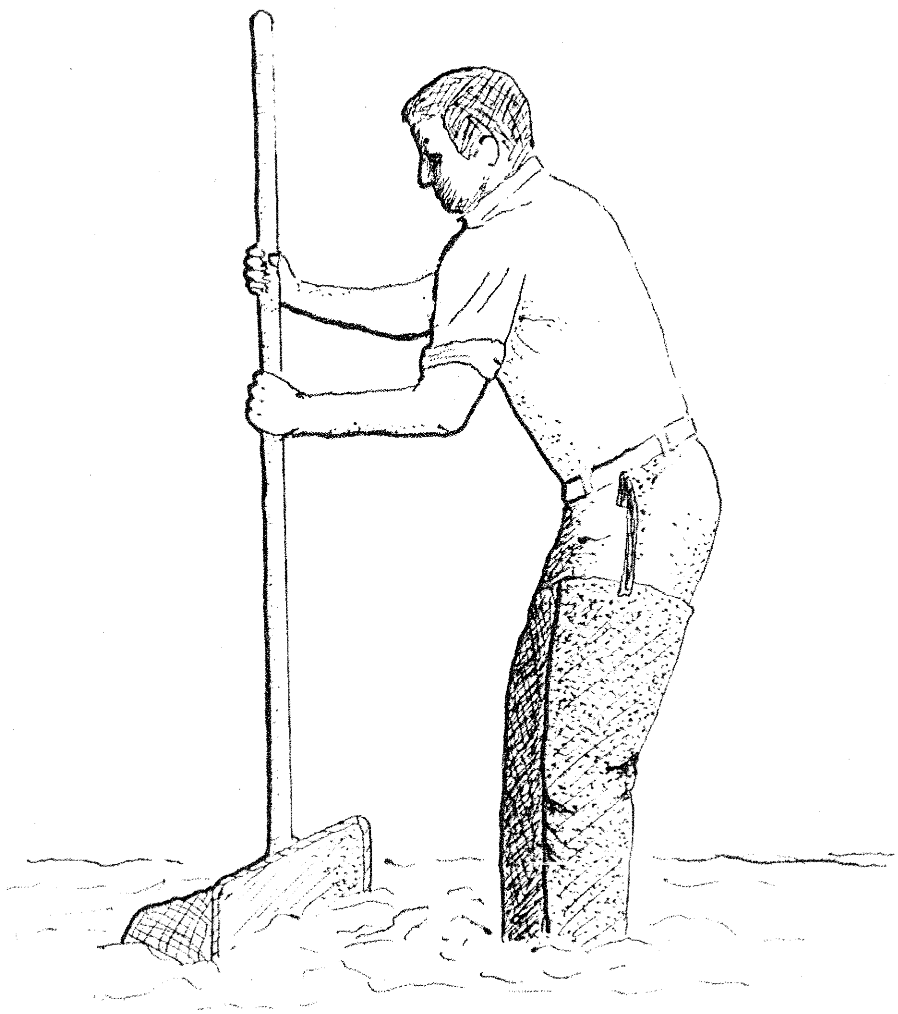
Percent model affinity criteria are used for traveling kick samples but not for multiplate samples.
* Diversity criteria are used for multiplate samples but not for traveling kick samples.

Water Quality Assessment Criteria for Navigable Flowing Waters

	Species Richness	Hilsenhoff Biotic Index	EPT Richness	Species Diversity
Non-Impacted	>21	0.00-7.00	>5	>3.00
Slightly Impacted	17-21	7.01-8.00	4-5	2.51-3.00
Moderately Impacted	12-16	8.01-9.00	2-3	2.01-2.50
Severely Impacted	0-11	9.01-10.00	0-1	0.00-2.00

Appendix VI.

The Traveling Kick Sample

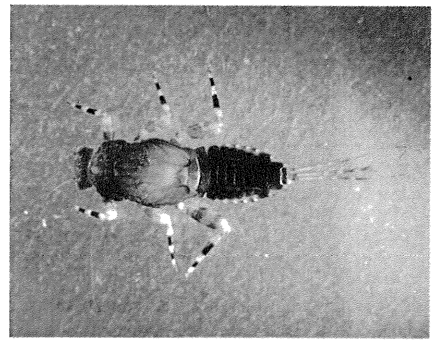


← current

Rocks and sediment in a riffle are dislodged by foot upstream of a net. Dislodged organisms are carried by the current into the net. Sampling continues for five minutes, as the sampler gradually moves downstream to cover a distance of five meters.

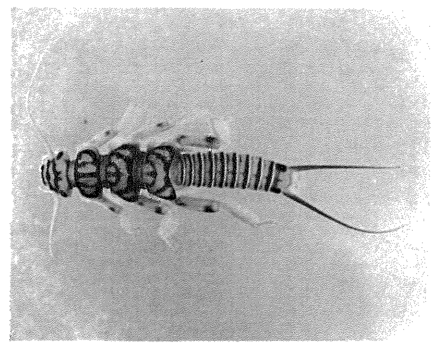
Appendix VII. A.
Aquatic Macroinvertebrates that Usually Indicate Good Water Quality

Mayfly nymphs are often the most numerous organisms found in clean streams. They are sensitive to most types of pollution, including low dissolved oxygen (less than 5 ppm), chlorine, ammonia, metals, pesticides, and acidity. Most mayflies are found clinging to the undersides of rocks.



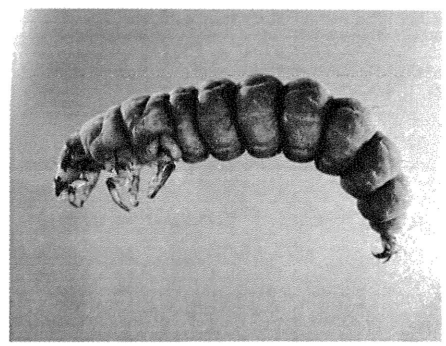
MAYFLIES

Stonefly nymphs are mostly limited to cool, well-oxygenated streams. They are sensitive to most of the same pollutants as mayflies, except acidity. They are usually much less numerous than mayflies. The presence of even a few stoneflies in a stream suggests that good water quality has been maintained for several months.



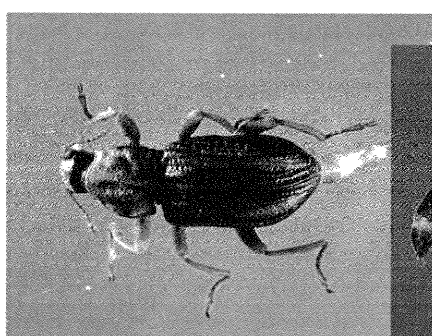
STONEFLIES

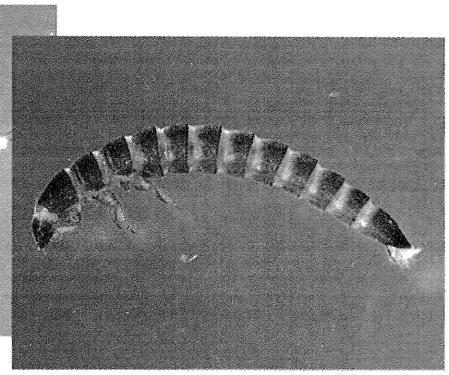
Caddisfly larvae often build a portable case of sand, stones, sticks, or other debris. Many caddisfly larvae are sensitive to pollution, although a few are tolerant. One family spins nets to catch drifting plankton, and is often numerous in nutrient-enriched stream segments.



CADDISFLIES

The most common beetles in streams are riffle beetles (adult and larva pictured) and water pennies (not shown). Most of these require a swift current and an adequate supply of oxygen, and are generally considered clean-water indicators.

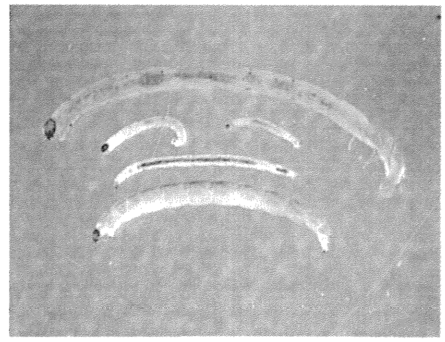




BEETLES

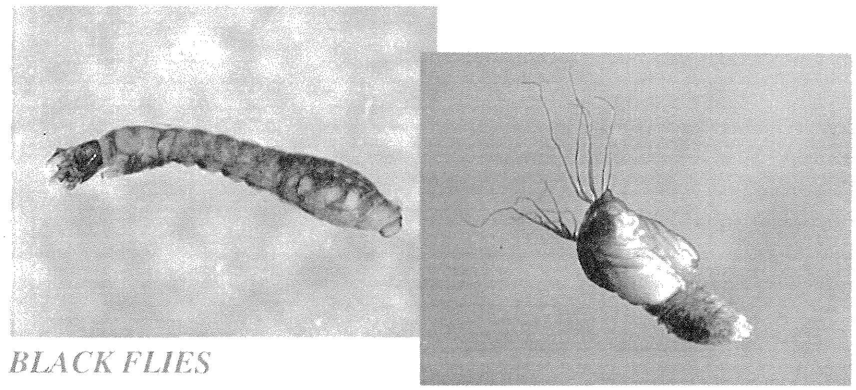
Appendix VII. B.
Aquatic Macroinvertebrates that Usually Indicate Poor Water Quality

Midges are the most common aquatic flies. The larvae occur in almost any aquatic situation. Many species are very tolerant to pollution. Large, red midge larvae called "bloodworms" indicate organic enrichment. Other midge larvae filter plankton, indicating nutrient enrichment when numerous.



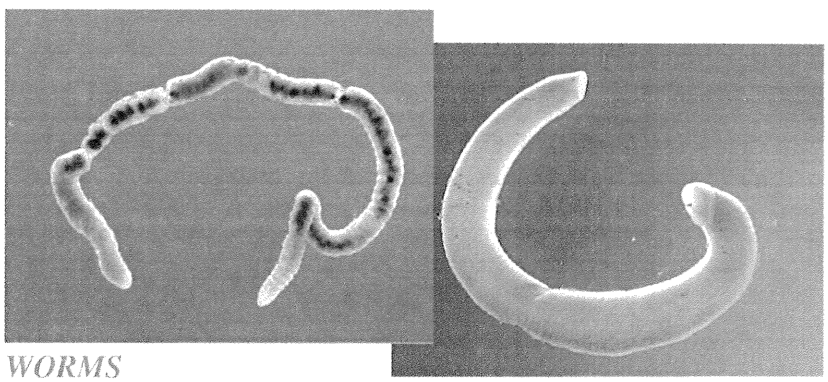
MIDGES

Black fly larvae have specialized structures for filtering plankton and bacteria from the water, and require a strong current. Some species are tolerant of organic enrichment and toxic contaminants, while others are intolerant of pollutants.



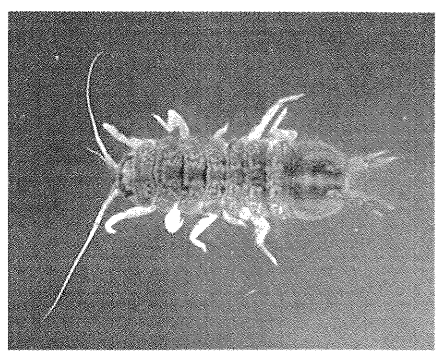
BLACK FLIES

The segmented worms include the leeches and the small aquatic worms. The latter are more common, though usually unnoticed. They burrow in the substrate and feed on bacteria in the sediment. They can thrive under conditions of severe pollution and very low oxygen levels, and are thus valuable pollution indicators. Many leeches are also tolerant of poor water quality.



WORMS

Aquatic sowbugs are crustaceans that are often numerous in situations of high organic content and low oxygen levels. They are classic indicators of sewage pollution, and can also thrive in toxic situations.



SOWBUGS

Digital images by Larry Abele, New York State Department of Environmental Conservation, Stream Biomonitoring Unit.

Appendix VIII. The Rationale of Biological Monitoring

Biological monitoring refers to the use of resident benthic macroinvertebrate communities as indicators of water quality. Macroinvertebrates are larger-than-microscopic invertebrate animals that inhabit aquatic habitats; freshwater forms are primarily aquatic insects, worms, clams, snails, and crustaceans.

Concept

Nearly all streams are inhabited by a community of benthic macroinvertebrates. The species comprising the community each occupy a distinct niche defined and limited by a set of environmental requirements. The composition of the macroinvertebrate community is thus determined by many factors, including habitat, food source, flow regime, temperature, and water quality. The community is presumed to be controlled primarily by water quality if the other factors are determined to be constant or optimal. Community components which can change with water quality include species richness, diversity, balance, abundance, and presence/absence of tolerant or intolerant species. Various indices or metrics are used to measure these community changes. Assessments of water quality are based on metric values of the community, compared to expected metric values.

Advantages

The primary advantages to using macroinvertebrates as water quality indicators are:

- they are sensitive to environmental impacts
- they are less mobile than fish, and thus cannot avoid discharges
- they can indicate effects of spills, intermittent discharges, and lapses in treatment
- they are indicators of overall, integrated water quality, including synergistic effects
- they are abundant in most streams and are relatively easy and inexpensive to sample
- they are able to detect non-chemical impacts to the habitat, e.g. siltation or thermal changes
- they are vital components of the aquatic ecosystem and important as a food source for fish
- they are more readily perceived by the public as tangible indicators of water quality
- they can often provide an on-site estimate of water quality
- they can often be used to identify specific stresses or sources of impairment
- they can be preserved and archived for decades, allowing for direct comparison of specimens
- they bioaccumulate many contaminants, so that analysis of their tissues is a good monitor of toxic substances in the aquatic food chain

Limitations

Biological monitoring is not intended to replace chemical sampling, toxicity testing, or fish surveys. Each of these measurements provides information not contained in the others. Similarly, assessments based on biological sampling should not be taken as being representative of chemical sampling. Some substances may be present in levels exceeding ambient water quality criteria, yet have no apparent adverse community impact.

Appendix IX. Glossary

anthropogenic: caused by human actions

assessment: a diagnosis or evaluation of water quality

benthos: organisms occurring on or in the bottom substrate of a waterbody

bioaccumulate: accumulate contaminants in the tissues of an organism

biomonitoring: the use of biological indicators to measure water quality

community: a group of populations of organisms interacting in a habitat

drainage basin: an area in which all water drains to a particular waterbody; watershed

EPT richness: the number of species of mayflies (Ephemeroptera), stoneflies (Plecoptera), and caddisflies (Trichoptera)in a sample or subsample

facultative: occurring over a wide range of water quality; neither tolerant nor intolerant of poor water quality

fauna: the animal life of a particular habitat

impact: a change in the physical, chemical, or biological condition of a waterbody

impairment: a detrimental effect caused by an impact

index: a number, metric, or parameter derived from sample data used as a measure of water quality

intolerant: unable to survive poor water quality

longitudinal trends: upstream-downstream changes in water quality in a river or stream

macroinvertebrate: a larger-than-microscopic invertebrate animal that lives at least part of its life in aquatic habitats

multiplate: multiple-plate sampler, a type of artificial substrate sampler of aquatic macroinvertebrates

organism: a living individual

PAHs: Polycyclic Aromatic Hydrocarbons, a class of organic compounds that are often toxic or carcinogenic.

rapid bioassessment: a biological diagnosis of water quality using field and laboratory analysis designed to allow assessment of water quality in a short turn-around time; usually involves kick sampling and laboratory subsampling of the sample

riffle: wadeable stretch of stream usually with a rubble bottom and sufficient current to have the water surface broken by the flow; rapids

species richness: the number of macroinvertebrate species in a sample or subsample

station: a sampling site on a waterbody

survey: a set of samplings conducted in succession along a stretch of stream

synergistic effect: an effect produced by the combination of two factors that is greater than the sum of the two factors

tolerant: able to survive poor water quality

Appendix X. Methods for Impact Source Determination

Definition Impact Source Determination (ISD) is the procedure for identifying types of impacts that exert deleterious effects on a waterbody. While the analysis of benthic macroinvertebrate communities has been shown to be an effective means of determining severity of water quality impacts, it has been less effective in determining what kind of pollution is causing the impact. Impact Source Determination uses community types or models to ascertain the primary factor influencing the fauna.

Development of methods The method found to be most useful in differentiating impacts in New York State streams was the use of community types based on composition by family and genus. It may be seen as an elaboration of Percent Model Affinity (Novak and Bode, 1992), which is based on class and order. A large database of macroinvertebrate data was required to develop ISD methods. The database included several sites known or presumed to be impacted by specific impact types. The impact types were mostly known by chemical data or land use. These sites were grouped into the following general categories: agricultural nonpoint, toxic-stressed, sewage (domestic municipal), sewage/toxic, siltation, impoundment, and natural. Each group initially contained 20 sites. Cluster analysis was then performed within each group, using percent similarity at the family or genus level. Within each group, four clusters were identified. Each cluster was usually composed of 4-5 sites with high biological similarity. From each cluster, a hypothetical model was then formed to represent a model cluster community type; sites within the cluster had at least 50 percent similarity to this model. These community type models formed the basis for Impact Source Determination (see tables following). The method was tested by calculating percent similarity to all the models and determining which model was the most similar to the test site. Some models were initially adjusted to achieve maximum representation of the impact type. New models are developed when similar communities are recognized from several streams.

Use of the ISD methods Impact Source Determination is based on similarity to existing models of community types (see tables following). The model that exhibits the highest similarity to the test data denotes the likely impact source type, or may indicate "natural," lacking an impact. In the graphic representation of ISD, only the highest similarity of each source type is identified. If no model exhibits a similarity to the test data of greater than 50%, the determination is inconclusive. The determination of impact source type is used in conjunction with assessment of severity of water quality impact to provide an overall assessment of water quality.

Limitations These methods were developed for data derived from subsamples of 100-organisms each that are taken from traveling kick samples of New York State streams. Application of these methods for data derived from other sampling methods, habitats, or geographical areas would likely require modification of the models.

ISD MODELS TABLE
NATURAL MACROINVERTEBRATE COMMUNITY TYPE

	A	B	C	D	E	F	G	H	I	J	K	L	M
PLATYHELMINTHES	-	-	-	-	-	-	-	-	-	-	-	-	-
OLIGOCHAETA	-	-	5	-	5	-	5	5	-	-	-	5	5
HIRUDINEA	-	-	-	-	-	-	-	-	-	-	-	-	-
GASTROPODA	-	-	-	-	-	-	-	-	-	-	-	-	-
SPHAERIIDAE	-	-	-	-	-	-	-	-	-	-	-	-	-
ASELLIDAE	-	-	-	-	-	-	-	-	-	-	-	-	-
GAMMARIDAE	-	-	-	-	-	-	-	-	-	-	-	-	-
Isonychia	5	5	-	5	20	-	-	-	-	-	-	-	-
BAETIDAE	20	10	10	10	10	5	10	10	10	10	5	15	40
HEPTAGENIIDAE	5	10	5	20	10	5	5	5	5	10	10	5	5
LEPTOPHLEBIIDAE	5	5	-	-	-	-	-	-	5	-	-	25	5
EPHEMERELLIDAE	5	5	5	10	-	10	10	30	-	5	-	10	5
Caenis/Tricorythodes	-	-	-	-	-	-	-	-	-	-	-	-	-
PLECOPTERA	-	-	-	5	5	-	5	5	15	5	5	5	5
Psephenus	5	-	-	-	-	-	-	-	-	-	-	-	-
Optioservus	5	-	20	5	5	-	5	5	5	5	-	-	-
Promoresia	5	-	-	-	-	-	25	-	-	-	-	-	-
Stenelmis	10	5	10	10	5	-	-	-	10	-	-	-	5
PHILOPOTAMIDAE	5	20	5	5	5	5	5	-	5	5	5	5	5
HYDROPSYCHIDAE	10	5	15	15	10	10	5	5	10	15	5	5	10
HELICOPSYCHIDAE/ BRACHYCENTRIDAE/ RHYACOPHILIDAE	5	5	-	-	-	20	-	5	5	5	5	5	-
SIMULIIDAE	-	-	-	5	5	-	-	-	-	5	-	-	-
Simulium vittatum	-	-	-	-	-	-	-	-	-	-	-	-	-
EMPIDIDAE	-	-	-	-	-	-	-	-	-	-	-	-	-
TIPULIDAE	-	-	-	-	-	-	-	-	5	-	-	-	-
CHIRONOMIDAE													
Tanypodinae	-	5	-	-	-	-	-	-	5	-	-	-	-
Diamesinae	-	-	-	-	-	-	5	-	-	-	-	-	-
Cardiocladius	-	5	-	-	-	-	-	-	-	-	-	-	-
Cricotopus/ Orthocladius	5	5	-	-	10	-	-	5	-	-	5	5	5
Eukiefferiella/ Tvetenia	5	5	10	-	-	5	5	5	-	5	-	5	5
Parametriocnemus	-	-	-	-	-	-	-	5	-	-	-	-	-
Chironomus	-	-	-	-	-	-	-	-	-	-	-	-	-
Polypedilum aviceps -	-	-	-	-	20	-	-	10	20	20	5	-	
Polypedilum (all others)	5	5	5	5	5	-	5	5	-	-	-	-	-
Tanytarsini	-	5	10	5	5	20	10	10	10	10	40	5	5
TOTAL	100	100	100	100	100	100	100	100	100	100	100	100	100

ISD MODELS TABLE (cont.)
NONPOINT NUTRIENT ENRICHMENT IMPACTED MACROINVERTEBRATE COMMUNITY TYPE

	A	B	C	D	E	F	G	H	I	J
PLATYHELMINTHES	-	-	-	-	-	-	-	-	-	-
OLIGOCHAETA	-	-	-	5	-	-	-	-	-	15
HIRUDINEA	-	-	-	-	-	-	-	-	-	-
GASTROPODA	-	-	-	-	-	-	-	-	-	-
SPHAERIIDAE	-	-	-	5	-	-	-	-	-	-
ASELLIDAE	-	-	-	-	-	-	-	-	-	-
GAMMARIDAE	-	-	-	5	-	-	-	-	-	-
Isonychia	-	-	-	-	-	-	-	5	-	-
BAETIDAE	5	15	20	5	20	10	10	5	10	5
HEPTAGENIIDAE	-	-	-	-	5	5	5	5	-	5
LEPTOPHLEBIIDAE	-	-	-	-	-	-	-	-	-	-
EPHEMERELLIDAE	-	-	-	-	-	-	-	5	-	-
Caenis/Tricorythodes	-	-	-	-	5	-	-	5	-	5
PLECOPTERA	-	-	-	-	-	-	-	-	-	-
Psephenus	5	-	-	5	-	5	5	-	-	-
Optioservus	10	-	-	5	-	-	15	5	-	5
Promoresia	-	-	-	-	-	-	-	-	-	-
Stenelmis	15	15	-	10	15	5	25	5	10	5
PHILOPOTAMIDAE	15	5	10	5	-	25	5	-	-	-
HYDROPSYCHIDAE	15	15	15	25	10	35	20	45	20	10
HELICOPSYCHIDAE/ BRACHYCENTRIDAE/ RHYACOPHILIDAE	-	-	-	-	-	-	-	-	-	-
SIMULIIDAE	5	-	15	5	5	-	-	-	40	-
Simulium vittatum	-	-	-	-	-	-	-	-	5	-
EMPIDIDAE	-	-	-	-	-	-	-	-	-	-
TIPULIDAE	-	-	-	-	-	-	-	-	-	5
CHIRONOMIDAE										
Tanypodinae	-	-	-	-	-	-	5	-	-	5
Cardiocladius	-	-	-	-	-	-	-	-	-	-
Cricotopus/ Orthocladius	10	15	10	5	-	-	-	-	5	5
Eukiefferiella/ Tvetenia	-	15	10	5	-	-	-	-	5	-
Parametriocnemus	-	-	-	-	-	-	-	-	-	-
Microtendipes	-	-	-	-	-	-	-	-	-	20
Polypedilum aviceps -	-	-	-	-	-	-	-	-	-	
Polypedilum (all others)	10	10	10	10	20	10	5	10	5	5
Tanytarsini	10	10	10	5	20	5	5	10	-	10
TOTAL	100	100	100	100	100	100	100	100	100	100

ISD MODELS TABLE (cont.)
MACROINVERTEBRATE COMMUNITY TYPES

	MUNICIPAL/INDUSTRIAL WASTES IMPACTED								TOXICS IMPACTED					
	A	B	C	D	E	F	G	H	A	B	C	D	E	F
PLATYHELMINTHES	-	40	-	-	-	5	-	-	-	-	-	-	5	-
OLIGOCHAETA	20	20	70	10	-	20	-	-	-	10	20	5	5	15
HIRUDINEA	-	5	-	-	-	-	-	-	-	-	-	-	-	-
GASTROPODA	-	-	-	-	-	5	-	-	-	5	-	-	-	5
SPHAERIIDAE	-	5	-	-	-	-	-	-	-	-	-	-	-	-
ASELLIDAE	10	5	10	10	15	5	-	-	10	10	-	20	10	5
GAMMARIDAE	40	-	-	-	15	-	5	5	5	-	-	-	5	5
Isonychia	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BAETIDAE	5	-	-	-	5	-	10	10	15	10	20	-	-	5
HEPTAGENIIDAE	5	-	-	-	-	-	-	-	-	-	-	-	-	-
LEPTOPHLEBIIDAE	-	-	-	-	-	-	-	-	-	-	-	-	-	-
EPHEMERELLIDAE	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Caenis/Tricorythodes	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PLECOPTERA	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Psephenus	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Optioservus	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Promoresia	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Stenelmis	5	-	-	10	5	-	5	5	10	15	-	40	35	5
PHILOPOTAMIDAE	-	-	-	-	-	-	-	40	10	-	-	-	-	-
HYDROPSYCHIDAE	10	-	-	50	20	-	40	20	20	10	15	10	35	10
HELICOPSYCHIDAE/ BRACHYCENTRIDAE/ RHYACOPHILIDAE	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SIMULIIDAE	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Simulium vittatum	-	-	-	-	-	-	20	10	-	20	-	-	-	5
EMPIDIDAE	-	5	-	-	-	-	-	-	-	-	-	-	-	-
CHIRONOMIDAE														
Tanypodinae	-	10	-	-	5	15	-	-	5	10	-	-	-	25
Cardiocladius	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cricotopus/ Orthocladius	5	10	20	-	5	10	5	5	15	10	25	10	5	10
Eukiefferiella/ Tvetenia	-	-	-	-	-	-	-	-	-	-	20	10	-	-
Parametriocnemus	-	-	-	-	-	-	-	-	-	-	-	5	-	-
Chironomus	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Polypedilum aviceps	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Polypedilum (all others)	-	-	-	10	20	40	10	5	10	-	-	-	-	5
Tanytarsini	-	-	-	10	10	-	5	-	-	-	-	-	-	5
TOTAL	100	100	100	100	100	100	100	100	100	100	100	100	100	100

ISD MODELS TABLE (cont.)
SEWAGE EFFLUENT, ANIMAL WASTES IMPACTED MACROINVERTEBRATE COMMUNITY TYPE

	A	B	C	D	E	F	G	H	I	J
PLATYHELMINTHES	-	-	-	-	-	-	-	-	-	-
OLIGOCHAETA	5	35	15	10	10	35	40	10	20	15
HIRUDINEA	-	-	-	-	-	-	-	-	-	-
GASTROPODA	-	-	-	-	-	-	-	-	-	-
SPHAERIIDAE	-	-	-	10	-	-	-	-	-	-
ASELLIDAE	5	10	-	10	10	10	10	50	-	5
GAMMARIDAE	-	-	-	-	-	10	-	10	-	-
Isonychia	-	-	-	-	-	-	-	-	-	-
BAETIDAE	-	10	10	5	-	-	-	-	5	-
HEPTAGENIIDAE	10	10	10	-	-	-	-	-	-	-
LEPTOPHLEBIIDAE	-	-	-	-	-	-	-	-	-	-
EPHEMERELLIDAE	-	-	-	-	-	-	-	-	5	-
Caenis/Tricorythodes	-	-	-	-	-	-	-	-	-	-
PLECOPTERA	-	-	-	-	-	-	-	-	-	-
Psephenus	-	-	-	-	-	-	-	-	-	-
Optioservus	-	-	-	-	-	-	-	-	5	-
Promoresia	-	-	-	-	-	-	-	-	-	-
Stenelmis	15	-	10	10	-	-	-	-	-	-
PHILOPOTAMIDAE	-	-	-	-	-	-	-	-	-	-
HYDROPSYCHIDAE	45	-	10	10	10	-	-	10	5	-
HELICOPSYCHIDAE/ BRACHYCENTRIDAE/ RHYACOPHILIDAE	-	-	-	-	-	-	-	-	-	-
SIMULIIDAE	-	-	-	-	-	-	-	-	-	-
Simulium vittatum	-	-	-	25	10	35	-	-	5	5
EMPIDIDAE	-	-	-	-	-	-	-	-	-	-
CHIRONOMIDAE										
Tanypodinae	-	5	-	-	-	-	-	-	5	5
Cardiocladius	-	-	-	-	-	-	-	-	-	-
Cricotopus/ Orthocladius	-	10	15	-	-	10	10	-	5	5
Eukiefferiella/ Tvetenia	-	-	10	-	-	-	-	-	-	-
Parametriocnemus	-	-	-	-	-	-	-	-	-	-
Chironomus	-	-	-	-	-	-	10	-	-	60
Polypedilum aviceps -	-	-	-	-	-	-	-	-	-	
Polypedilum (all others)	10	10	10	10	60	-	30	10	5	5
Tanytarsini	10	10	10	10	-	-	-	10	40	-
TOTAL	100	100	100	100	100	100	100	100	100	100

ISD MODELS TABLE (cont.)
MACROINVERTEBRATE COMMUNITY TYPES

	SILTATION IMPACTED					IMPOUNDMENT IMPACTED									
	A	B	C	D	E	A	B	C	D	E	F	G	H	I	J
PLATYHELMINTHES	-	-	-	-	-	-	10	-	10	-	5	-	50	10	-
OLIGOCHAETA	5	-	20	10	5	5	-	40	5	10	5	10	5	5	-
HIRUDINEA	-	-	-	-	-	-	-	-	-	5	-	-	-	-	-
GASTROPODA	-	-	-	-	-	-	-	10	-	5	5	-	-	-	-
SPHAERIIDAE	-	-	-	5	-	-	-	-	-	-	-	-	5	25	-
ASELLIDAE	-	-	-	-	-	-	5	5	-	10	5	5	5	-	-
GAMMARIDAE	-	-	-	10	-	-	-	10	-	10	50	-	5	10	-
Isonychia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BAETIDAE	-	10	20	5	-	-	5	-	5	-	-	5	-	-	5
HEPTAGENIIDAE	5	10	-	20	5	5	5	-	5	5	5	5	-	5	5
LEPTOPHLEBIIDAE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
EPHEMERELLIDAE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Caenis/Tricorythodes	5	20	10	5	15	-	-	-	-	-	-	-	-	-	-
PLECOPTERA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Psephenus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5
Optioservus	5	10	-	-	-	-	-	-	-	-	-	-	-	5	-
Promoresia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Stenelmis	5	10	10	5	20	5	5	10	10	-	5	35	-	5	10
PHILOPOTAMIDAE	-	-	-	-	-	5	-	-	5	-	-	-	-	-	30
HYDROPSYCHIDAE	25	10	-	20	30	50	15	10	10	10	10	20	5	15	20
HELICOPSYCHIDAE/ BRACHYCENTRIDAE/ RHYACOPHILIDAE	-	-	-	-	-	-	-	-	-	-	-	-	-	5	-
SIMULIIDAE	5	10	-	-	5	5	-	5	-	35	10	5	-	-	15
EMPIDIDAE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CHIRONOMIDAE															
Tanypodinae	-	-	-	-	-	-	5	-	-	-	-	-	-	-	-
Cardiocladius	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cricotopus/ Orthocladius	25	-	10	5	5	5	25	5	-	10	-	5	10	-	-
Eukiefferiella/ Tvetenia	-	-	10	-	5	5	15	-	-	-	-	-	-	-	-
Parametriocnemus	-	-	-	-	-	5	-	-	-	-	-	-	-	-	-
Chironomus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Polypedilum aviceps -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Polypedilum (all others)	10	10	10	5	5	5	-	-	20	-	-	5	5	5	5
Tanytarsini	10	10	10	10	5	5	10	5	30	-	-	5	10	10	5
TOTAL	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100